Unnamed Tributary, Chickahominy River: Benthic TMDL Development

1st Public Meeting
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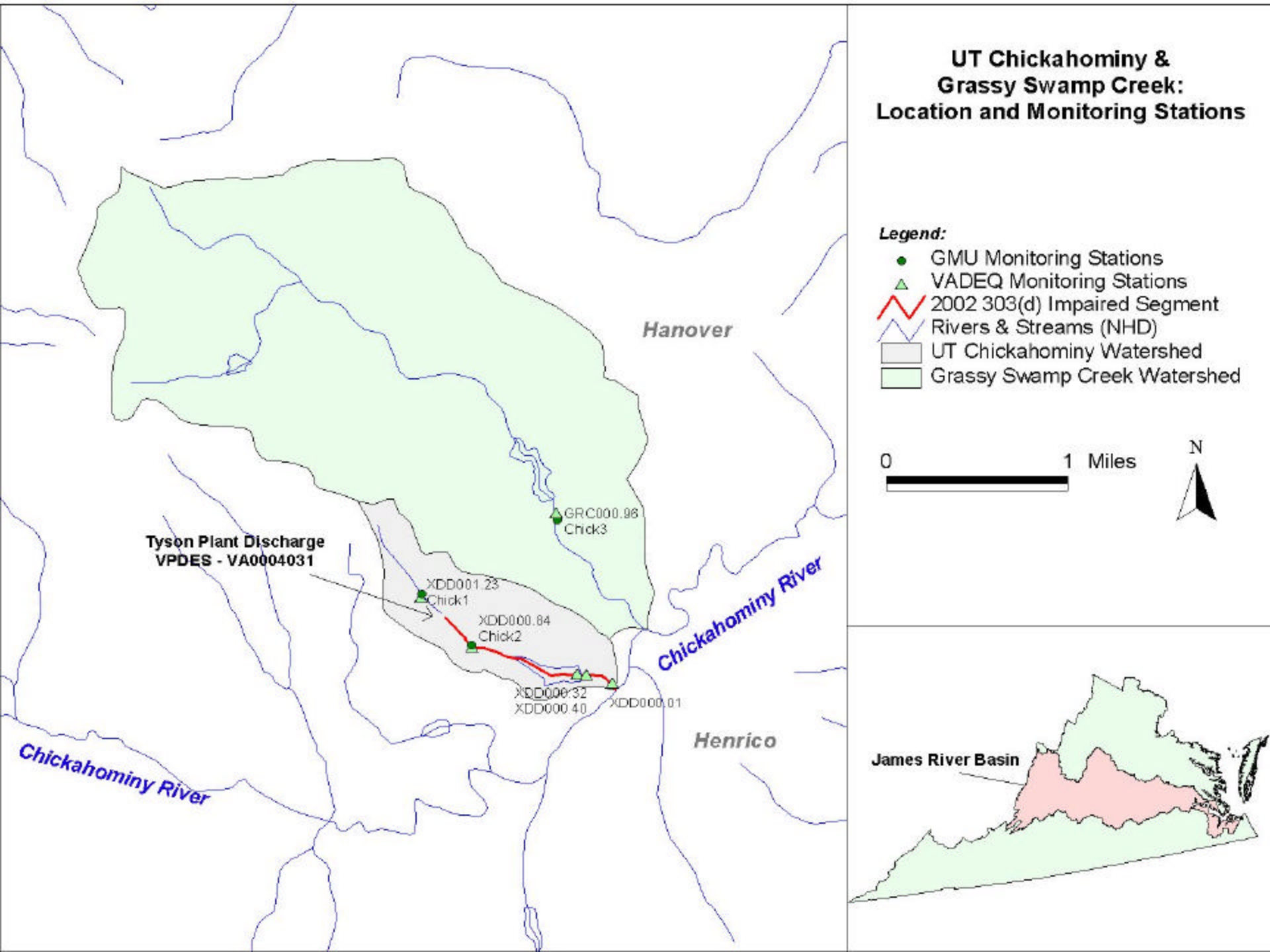

UT Chickahominy &
Grassy Swamp Creek:
Location and Monitoring Stations
Legend:
GMU Monitoring Stations
VADEQ Monitoring Stations
2002 303(d) Impaired Segment
Rivers & Streams (NHD)
UT Chickahominy Watershed
Grassy Swamp Creek Watershed
0
1 Miles
N
Hanover
Henrico
Chickahominy River
Chickahominy River
Tyson Plant Discharge
VPDES - VA0004031
GRC000.96
Chick3
XDD001.23
Chick1
XDD000.84
Chick2
XDD000.32
XDD000.40
XDD000.01
James River Basin

Biomonitoring & Assessment

- General Standard (9 VAC 25-260-20): *"All state waters shall be free from substances…which are harmful to human, animal, plant, or aquatic life."*
- EPA Rapid Bioassessment Protocol (RBP)
- Measurements of the benthic community. These "metrics" are used to determine the condition of the benthic community.
- Target Station vs. Reference Station (metric comparisons)
- Virginia Assessment Guidance: RBP score of moderately or severely impaired.

Benthic TMDL Development

Problem: Impaired streams do not support a healthy benthic macroinvertebrate community.

Questions:

- What factors are causing the problem?
- For each stressor, what level of improvement is needed? Virginia Water Quality Standards do not contain numeric criteria for sedimentation, nutrients, and other stressors.

Technical Approach: Non-impaired reference streams/ watersheds will be used to identify stressors and the level of improvement needed for each stressor (i.e. TMDL endpoints)

Reference Watershed Selection

- Goal: Identify similar, unimpaired watersheds that can be used to help identify stressors and develop TMDLs.

- Consider using Grassy Swamp Creek or other reference streams in the area with similar attributes.

- Data used:

Biomonitoring Data	Ecoregion coverages
Topography	Land use distribution
Soils	Watershed size
Water quality data	Point source inventory

Bioassessment Index Comparison

Station ID	Stream	Sample Date	Virginia Stream Condition Index Score
UT Chickahominy Watershed			
XDD001.23	Upstream of Tyson discharge, downstream of headwaters impoundment	11/22/94	17
		5/1/95	25
		5/6/96	23
		10/23/96	20
		5/19/97	32
		11/12/97	31
		5/24/98	17
		Average	25
XDD000.84	Below Tyson discharge	11/22/94	9
		5/1/95	28
		5/6/96	32
		10/23/96	33
		5/19/97	31
		11/12/97	36
		5/24/98	31
		4/16/02	33
		9/24/02	29
		Average	29
XDD000.32	Below downstream impoundment	7/1/02	21
		9/23/02	17
		Average	19
Potential Reference Stream			
GRC000.96	Grassy Swamp Creek, below impoundment	7/1/02	47
		9/24/02	32
		Average	40

Reference Watershed Notes

- Summary: Non-impaired reference streams/watersheds will be used to identify stressors and to determine acceptable pollutant limits.

- This approach is needed because standards do not exist for the some potential stressors (i.e. sedimentation, nutrients, etc.)

- Pollutant limits (TMDL endpoints) will be based on the information gained from the reference watershed.

Stressor Identification Analyses

- Candidate Causes:
  - Sedimentation
  - Degraded water quality (e.g., low DO, ammonia)
  - Toxic pollutants
  - Habitat impacts (riparian zone)

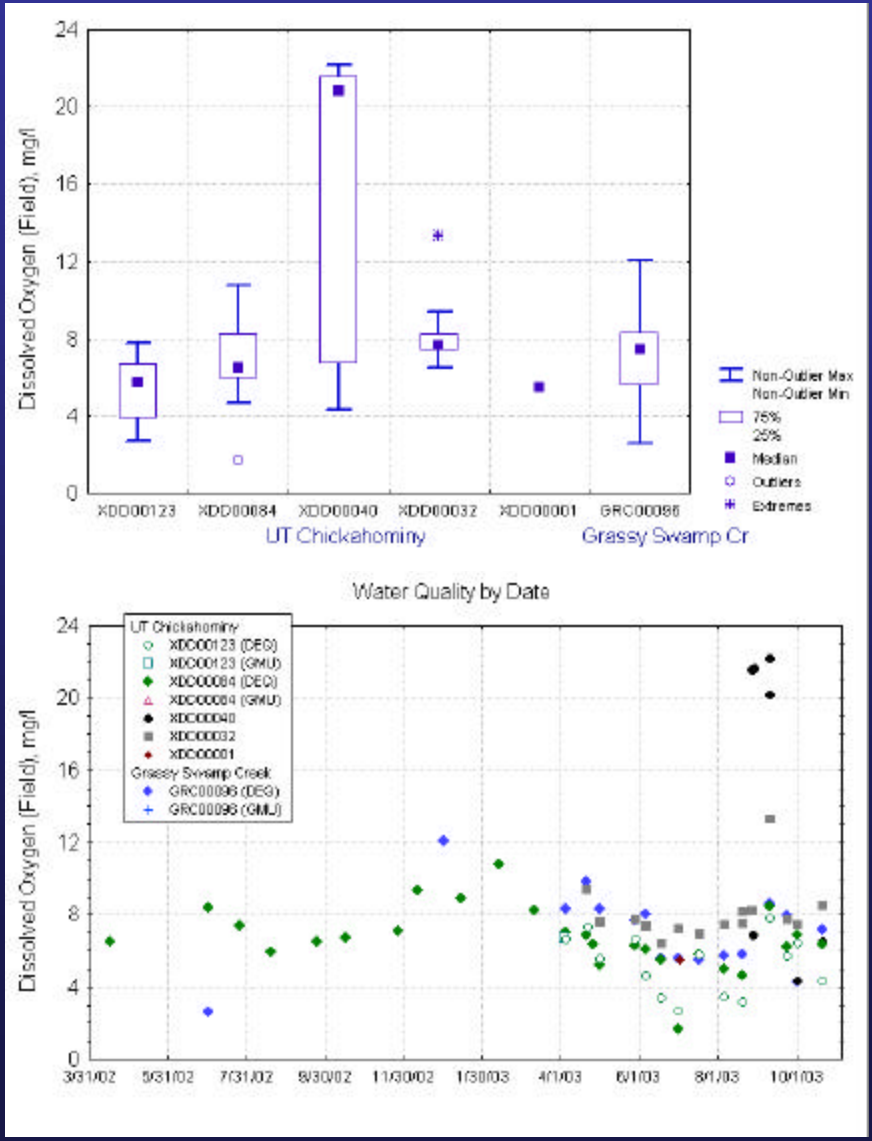
- Identified stressors need to be reduced to allow for improvement in the benthic community

- Data Analyses
  - Ambient Water Quality Data: Temperature, DO, BOD, sedimentation (TSS), nutrients, etc.
  - RBP habitat data
  - 24-hour dissolved oxygen data
  - GMU water quality and biomonitoring data
  - EPA toxicity tests: Measured survival/growth/reproduction of test organisms

Site Visit Pictures (April 2003)

Dissolved Oxygen Analyses

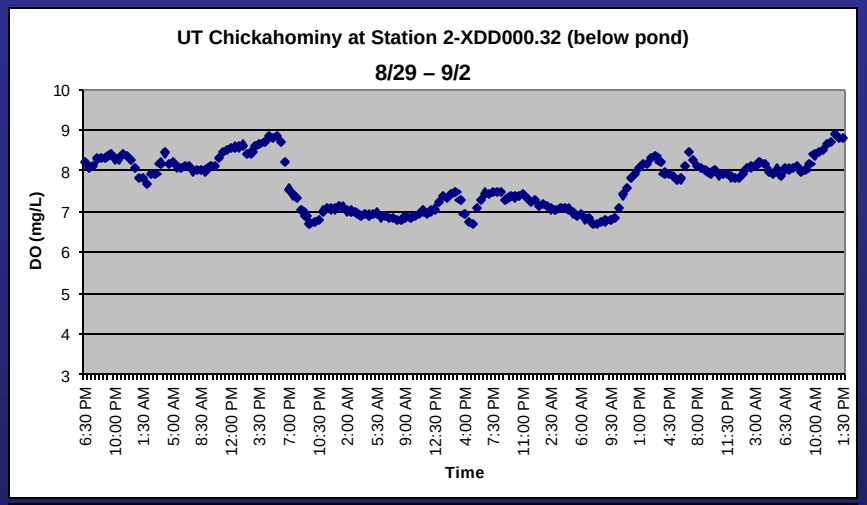
AWQM Data Comparison

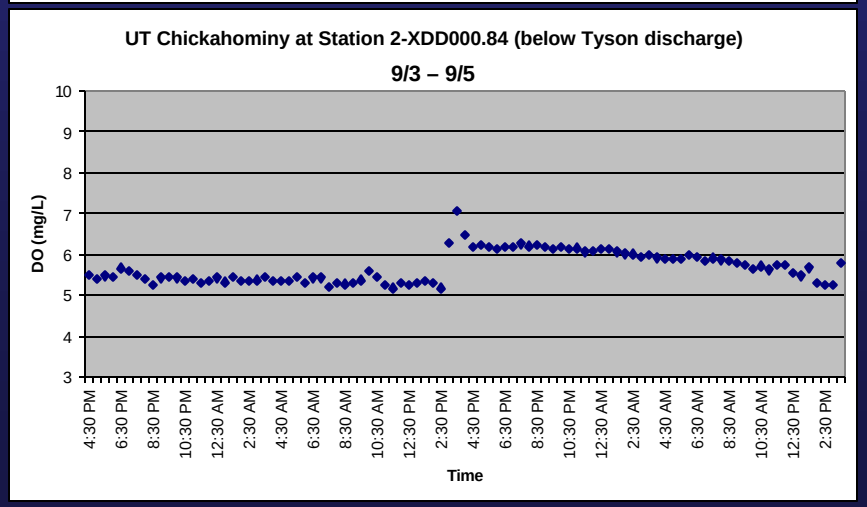


Virginia's DO Standards
(Class III Nontidal Waters):

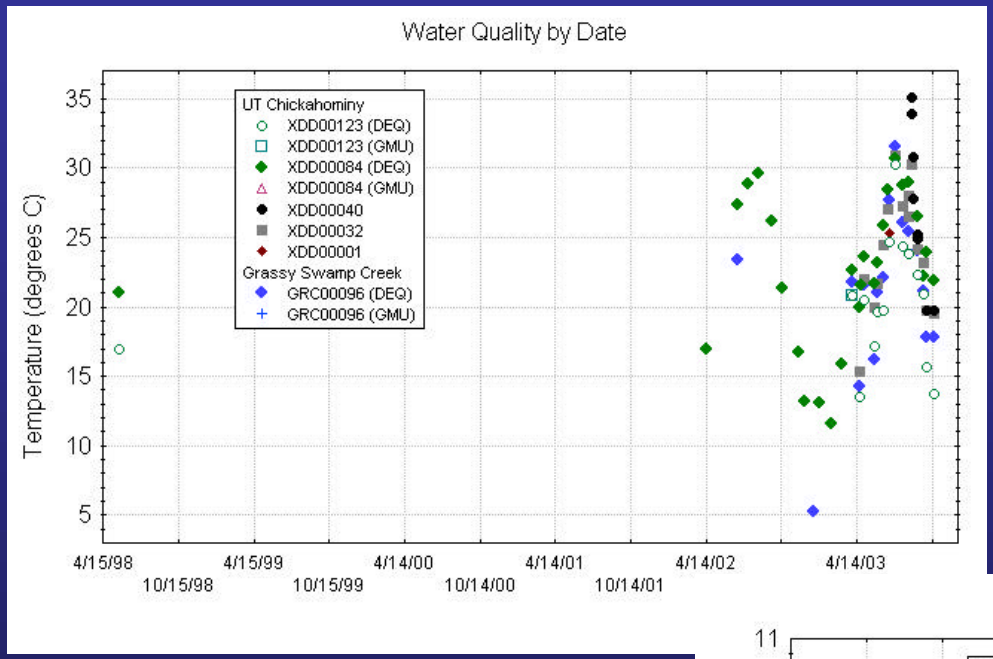
- 5.0 mg/L daily average
- 4.0 mg/L minimum

2003 Diurnal DO study



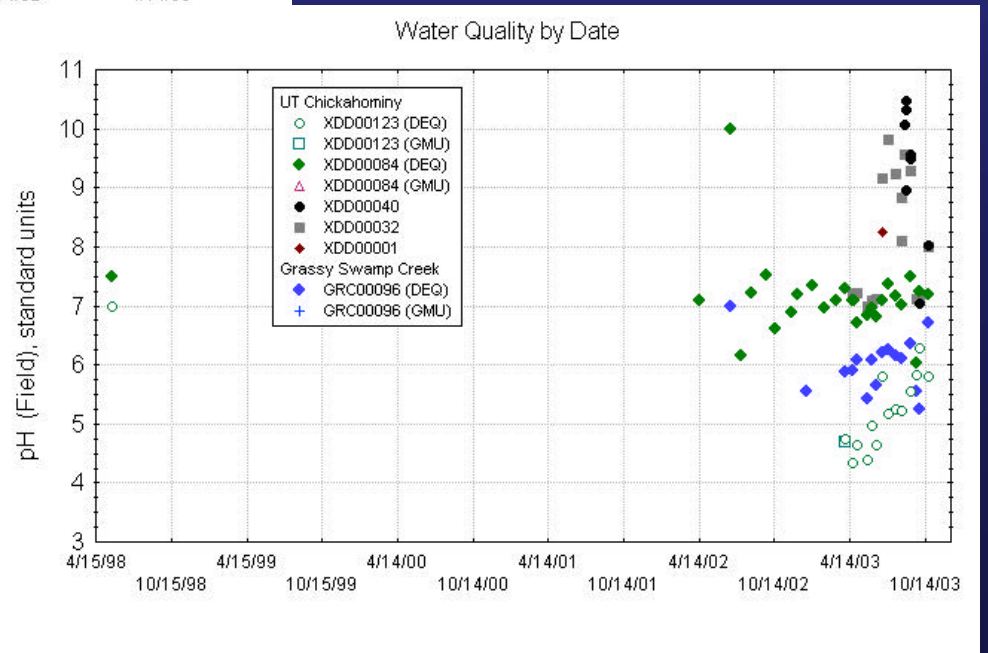


Temperature and pH Analyses

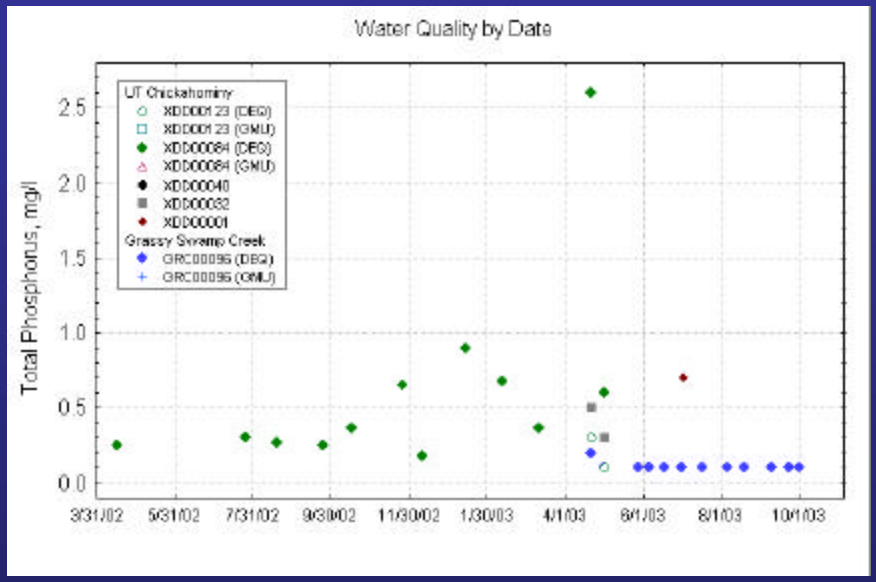


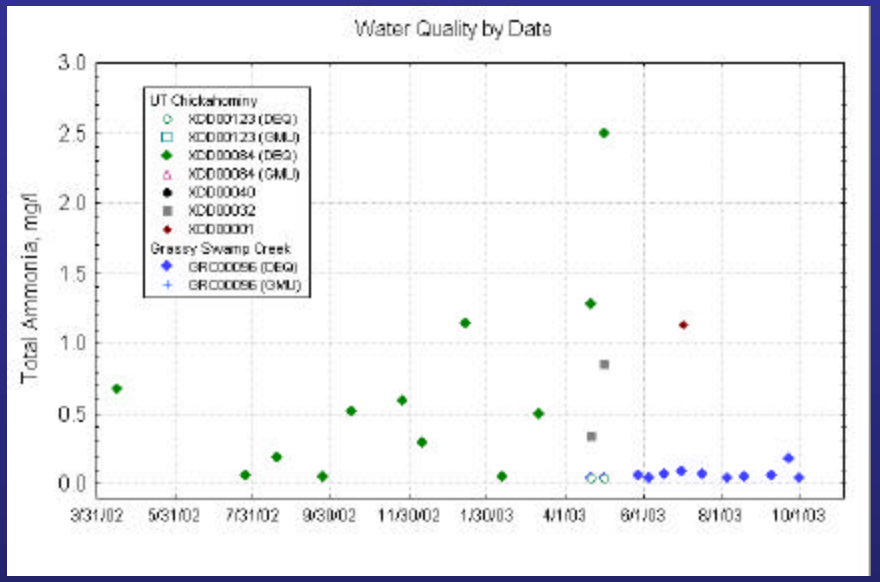
Virginia's Temperature and pH Standards (Class III Nontidal Waters):

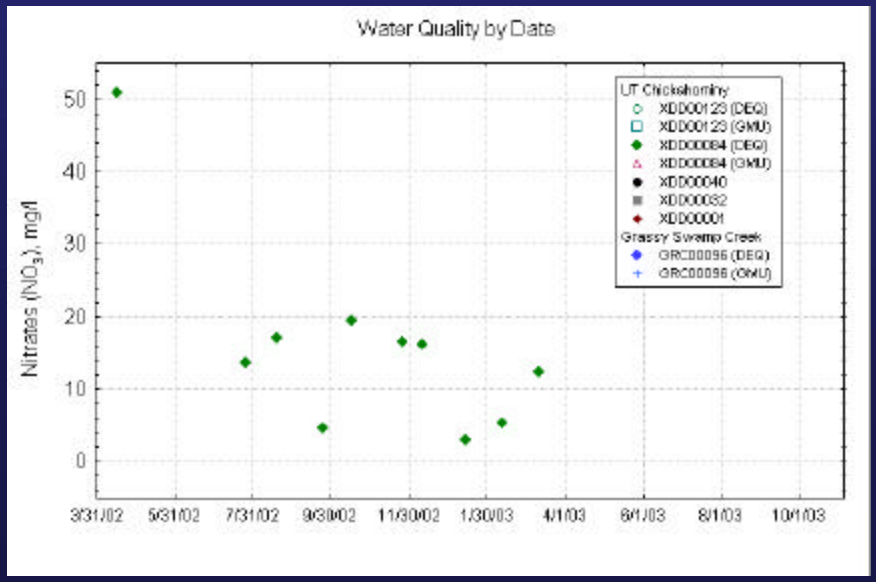
- 32 degrees Celsius – Maximum Temperature
- pH between 6.0 and 9.0

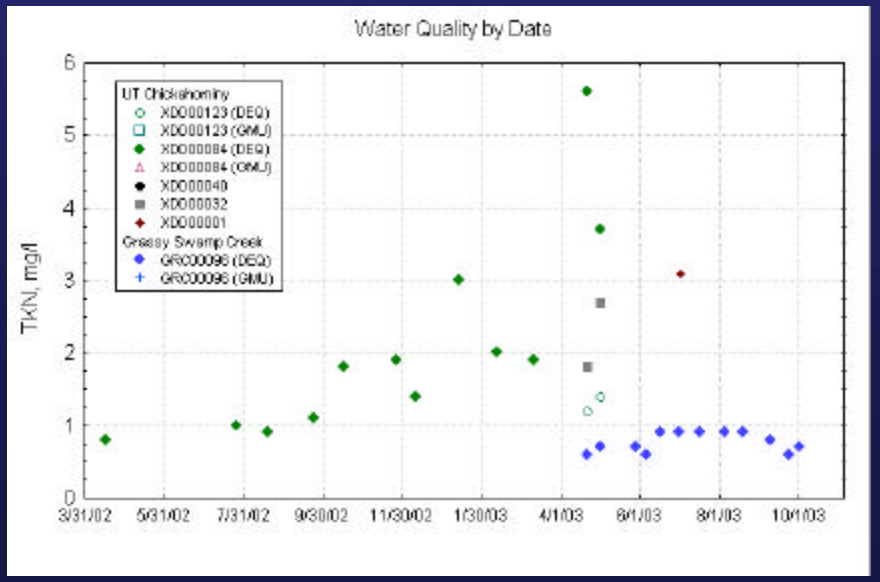


Nutrient Analyses

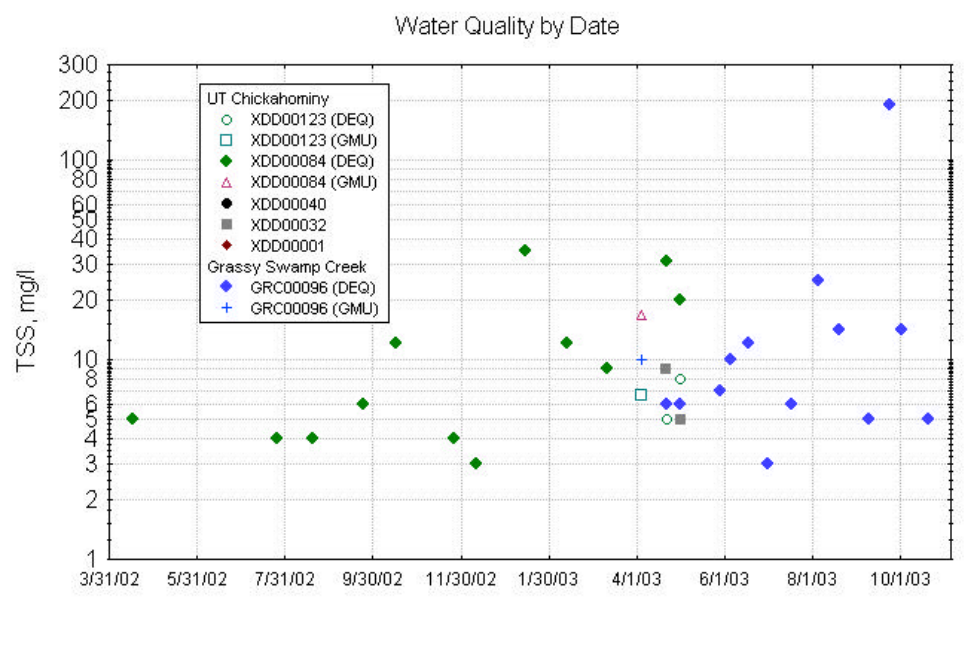








Sedimentation Analysis



Station	Data Period	Total Habitat	Bank Condition	Bank Vegetative Protection	Embed-dedness/Pool Substrate
XDD001.23	11/94 - 5/98	106	12	10	7
XDD000.84	11/94 - 5/98	94	7	6	6
XDD000.32	7/02 - 9/02	126	12	14	12
GRC000.96	7/02 - 9/02	111	10	10	7

Station	Date	Instream Cover	Riparian Vegetation Width	Sediment Deposition
XDD001.23	11/94 - 5/98	8	12	17
XDD000.84	11/94 - 5/98	5	10	10
XDD000.32	7/02 - 9/02	13	20	11
GRC000.96	7/02 - 9/02	12	20	8

Point Source Information

- Tyson Foods – VPDES #VA0004031. Only point source discharge in the watershed.
- Discharges to UT Chickahominy <1 mile upstream of DEQ Station XDD000.84
- Data Period: 4/10/99 – 6/10/03
  Exceedances for TSS and
  Residual Chlorine
- Ammonia exceedance recorded in
  7/03 that corresponded with a
  fish kill
- Concentration limits for Total Phosphorus are greater than the DEQ 305(b) assessment criteria (0.2 mg/L)

Parameter	Quantity Limit	Concentration Limit
pH	Concentration: 6.0 – 9.0 std. units	N/A
BOD5	28.4 kg/day (monthly avg)	6 mg/L (monthly avg) 8 mg/L (daily max)
TSS	23.7 kg/day (monthly avg)	5 mg/L (monthly avg) 7.5 (daily max)
Fecal Coliform	N/A	200 cfu/100mL (monthly avg)
DO	N/A	5 mg/L (daily min)
Total Phosphorus	1.4 kg/day (monthly avg) 2.4 (daily max)	0.3 mg/L (monthly avg) 0.5 mg/L (daily max)
Ammonia	9.5 kg/day (monthly avg)	2 mg/L (monthly avg)
Settleable Solids	N/A	0.1 ml/L (monthly avg)
Residual Chlorine, Inst. Max	N/A	7.97 ppb (monthly avg) 16.09 ppb (daily max)
Oil & Grease	47.3 kg/day (monthly avg) 71 kg/day (daily max)	10 mg/L (monthly avg) 15 mg/L (daily max)

UT Chickahominy – Watershed/Stream Observations

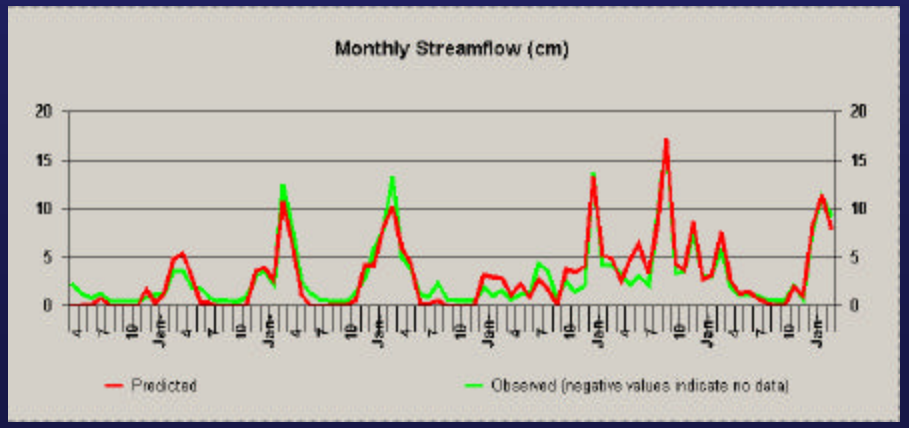
- Headwaters is very tannic. There is an impoundment located just above DEQ station XDD001.23, which impacts conditions at this site. Streamflow is minimal at this location and the riparian zone is disturbed.
- Large waterfowl population at the Tyson “Freshwater Pond”. Excess nutrient contributions to the stream.
- Minimal riparian vegetation along the stream corridor, primarily downstream of Tyson property.
- Bottom substrate at Station XDD000.84 is disturbed and consists of a mucky subsurface layer.
- Tyson discharge dominates streamflow (>90%). Excess inputs of nitrogen and phosphorus to the stream.
- The farm pond located just upstream of Station XDD000.32 is hypereutrophic and is likely anoxic at depth.

UT Chickahominy – Potential Stressors

- Stream conditions are poorest at Station XDD000.84, located downstream of the Tyson discharge. This site has minimal riparian vegetation and poor bottom substrate.
- Exceedance of the chronic ammonia criteria recorded on 7/1/03 at Station XDD000.01. Attributed to point source.
- EPA toxicity test results do not indicate acute/chronic toxicity (Fall 2003 samples from UT Chickahominy).
- High nutrient concentrations may limit benthic community diversity.
- Likely benthic community stressors include sedimentation, episodic high ammonia levels, minimal riparian vegetation, disturbed bottom substrate, and high nutrient concentrations (from point and nonpoint sources).

Watershed Modeling

- Purpose: To simulate target and reference watersheds in order to determine sediment loading and the necessary reductions.
- GWLF (Generalized Watershed Loading Functions) model is used estimate sediment and nutrient loading and develop TMDLs.
- Model attributes
  - Continuous simulation model
  - Models surface runoff using the Soil Conservation Service curve numbers
  - Based on the Universal Soil Loss Equation (USLE)
- Margin of safety: 10% of load reserved
- Reference watershed
  - TMDLs for impaired streams based on reference watershed loading



Source Assessment Example

- Sediment
  - Soil erosion (pervious lands, esp. agricultural land and construction areas)
  - Urban runoff (build-up and washoff of soil particles, debris, etc.)
  - Streambank erosion
  - Point source discharges

TMDL Example – Sediment (% contribution by source)

Existing

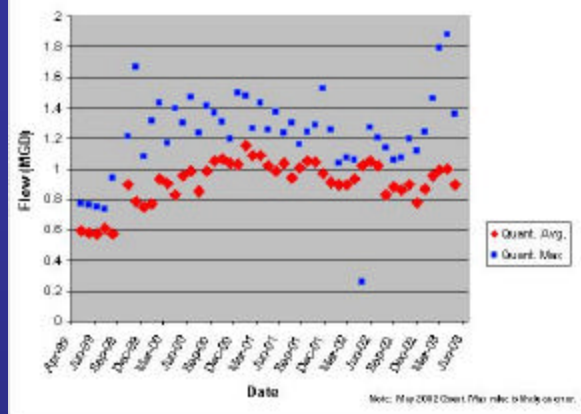
Source Category	Stream A
Row Crops	60
Pasture/Hay	20
Transitional / Barren	2
Forest	2
Water	0
Urban	10
Groundwater	0
Point Sources	6
Septic Systems	0
Existing Load (lbs/year)	11,345,488

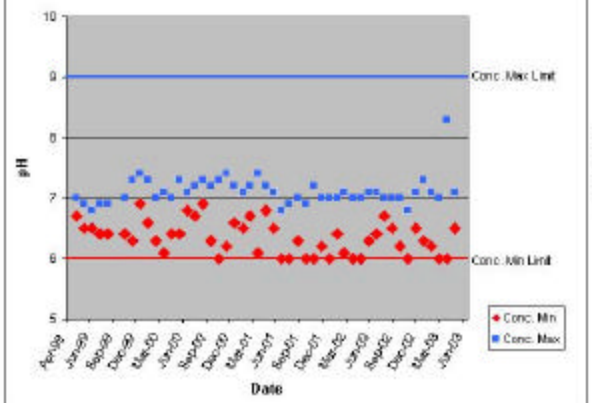
Allocation Loads

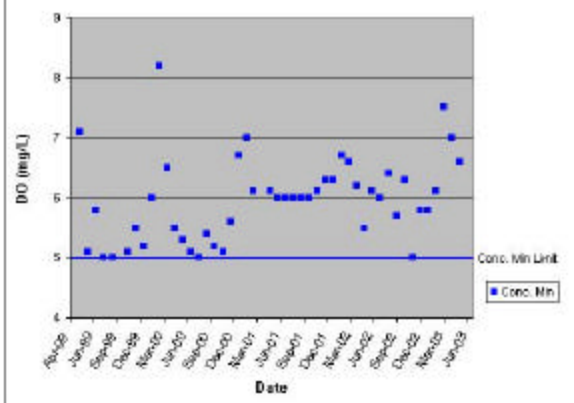
Source Category	Stream A (% reduction)
Row Crops	45%
Pasture/Hay	45
Transitional / Barren	70
Forest	0
Water	0
Urban	37
Groundwater	0
Point Sources	0
Septic Systems	0
Overall % Reduction	45%
TMDL Load – minus MOS (lbs/year)	6,270,928

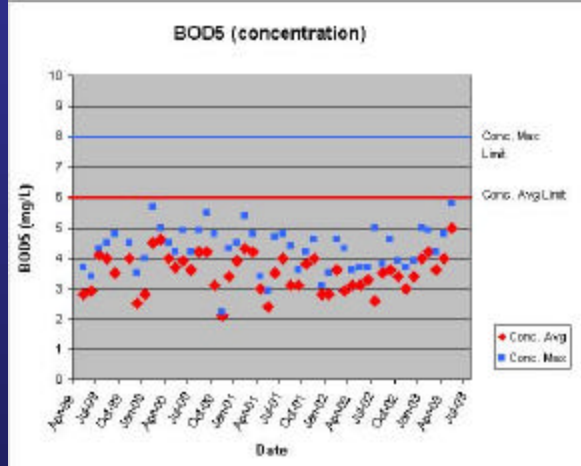
Next Steps

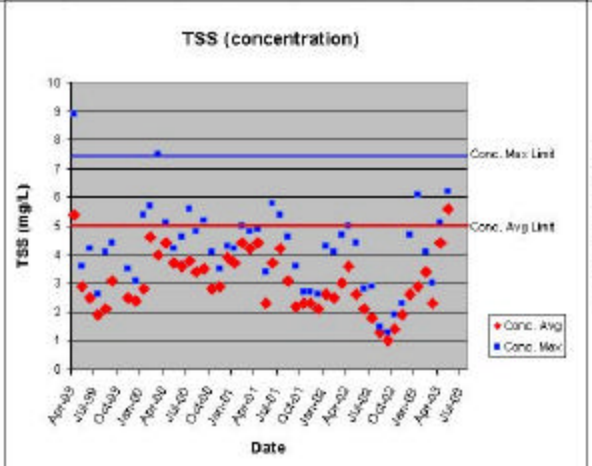
- Finalize stressor identification and determine TMDL pollutants.
- Complete watershed modeling setup and calibration (hydrology and water quality).
- Quantify existing pollutant loads and sources in the watershed.
- Examine possible TMDL allocation scenarios.

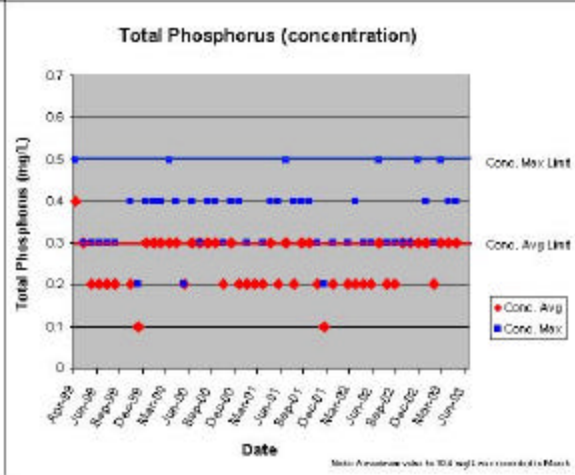

Flow
Flow (MGD)
Quant. Avg.
Quant. Max
Date

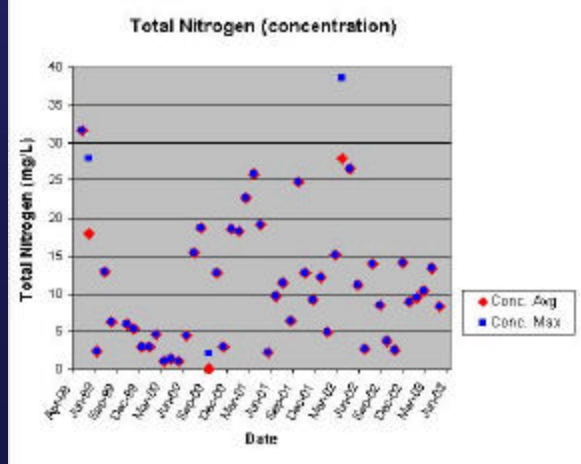

pH
pH
Conc. Max Limit
Conc. Min Limit
Conc. Min
Conc. Max
Date

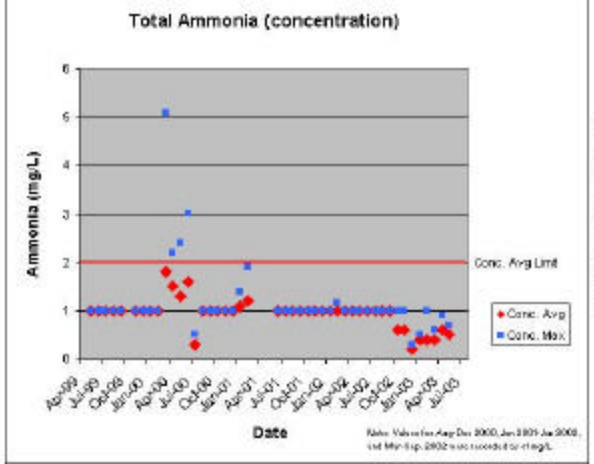

Dissolved Oxygen
DO (mg/L)
Conc. Min Limit
Conc. Min
Date

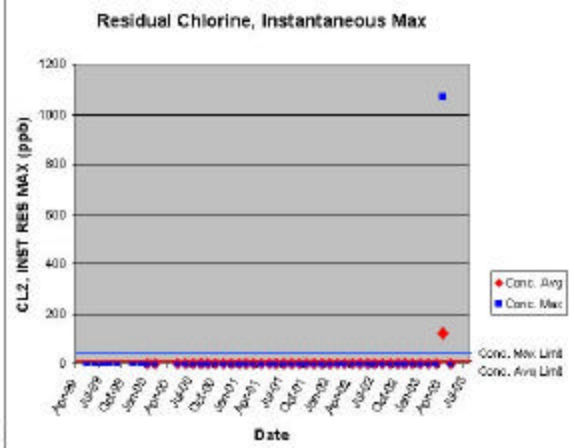

BOD5 (concentration)
BOD5 (mg/L)
Conc. Max Limit
Conc. Avg Limit
Conc. Avg
Conc. Max
Date


TSS (concentration)
TSS (mg/L)
Conc. Max Limit
Conc. Avg Limit
Conc. Avg
Conc. Max
Date


Total Phosphorus (concentration)
Total Phosphorus (mg/L)
Conc. Max Limit
Conc. Avg Limit
Conc. Avg
Conc. Max
Date


Total Nitrogen (concentration)
Total Nitrogen (mg/L)
Conc. Avg
Conc. Max
Date


Total Ammonia (concentration)
Ammonia (mg/L)
Conc. Avg Limit
Conc. Avg
Conc. Max
Date


Residual Chlorine, Instantaneous Max
CL2, INST RES MAX (ppb)
Conc. Avg
Conc. Max
Conc. Max Limit
Conc. Avg Limit
Date